FORM PTO-1390 (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: STOCK-02

U.S. APPLICATION NO (If known, see 37 CFR 1.5): 09/890056

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/SE00/00024	10 JAN 2000	28 JAN 1999

TITLE OF INVENTION: METHOD OF DETERMINING AN ILLUMINATED SURFACE

APPLICANT(S) FOR DO/EO/US: Per-Ake JOHANSSON and Peter HANSSON

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [X] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [X] is attached hereto (required only if not communicated by the International Bureau).
   b. [ ] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [ ] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [ ] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [X] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (unexecuted)
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [ ] Other items or information:

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/890056	PCT/SE00/00024	STOCK-02

21. [X] The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):	CALCULATIONS PTO USE ONLY
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1000.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $860.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $710.00	
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) $690.00	
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [X] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ 130.00

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	15 - 20 =	0	x $18.00	$ 0
Independent claims	1 - 3 =	0	x $80.00	$ 0
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $270.00	$ 0
TOTAL OF ABOVE CALCULATIONS =				$ 990.00
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.			+	$
SUBTOTAL =				$ 990.00
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$ 0
TOTAL NATIONAL FEE =				$ 990.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$
TOTAL FEES ENCLOSED =				$ 990.00
			Amount to be refunded:	$
			charged:	$

a. [X] A check in the amount of $ 990.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 23-3000 A duplicate copy of this sheet is enclosed.

d. [ ] Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO.

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SIGNATURE

Kevin G. Rooney
NAME

36,330
REGISTRATION NUMBER

PATENT

I hereby certify that this paper is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service (Express Mail No. EL915035195US) under 37 C.F.R. § 1.10 on the date indicated below and is addressed to the Assistant Commissioner, Box PCT, Washington, D.C. 20231

Ryan Cummins
Name of Person Mailing Paper or Fee

Ryan Cummins
Signature of Person Mailing Paper or Fee

July 25, 2001
Date

Applicants:	Per-Åke JOHANSSON and Peter HANSSON
Serial No:	Unknown (National filing under § 171 of PCT/SE00/00024)
Filing Date:	July 25, 2001
Art Unit:	Unknown
Examiner:	Unknown
Title:	METHOD OF DETERMINING AN ILLUMINATED SURFACE
Atty Docket:	STOCK-02

Cincinnati, OH July 25, 2001

BOX PCT
Assistant Commissioner of Patents
Washington, D.C. 20231

Sir:

PRELIMINARY AMENDMENT

Prior to examination, please preliminarily amend this application as follows:

IN THE CLAIMS:

Please amend claims 4-6 and 9, 10, 12 and 13 as follows:

4. (Amended) The method according to claim 3, characterised in that the sum $(I_1(x,y)+I_2(x,y))$ of the recorded intensities over the surface issued to obtain an essentially topographically neutral reflectance image of the surface.

5. (Amended) The method according to claim 1, characterised in that the intensity of the first image is recorded with light incident from a first direction and that the intensity of the second image is recorded with light incident from a second direction that is opposite to the reflection angle of the first direction.

6. (Amended) The method according to claim 1, characterised by calculation of the derivative of the area by

$$f'_x(x,y) \approx \frac{1}{\tan\gamma} \frac{I_1(x,y) - I_2(x,y)}{I_1(x,y) - I_2(x,y)}$$

where γ is the angle of incidence of the light.

8. (Amended) The method according to claim 7, characterised by integration of the derivative in order to obtain the height function of the surface.

9. (Amended) The method according to claim 1, characterised by polarisation of the incident light and thereto cross wise polarisation of the reflected light in order to eliminate reflections in the surface and obtain the said diffusely reflected light.

10. (Amended) The method according to claim 1, characterised in that the first image is recorded with light in a first wavelength region and that the second image is recorded with light in a second wavelength region, distinct from the first wavelength region.

12. (Amended) The method according to claim 11, characterised in that the first and the second images are recorded simultaneously.

13. (Amended) Use of the method according to claim 1 for determining the topography of a paper surface.

Please add new claims 14 and 15 as follows:

14. The method according to claim 6, characterized by integration of the derivative in order to obtain the height function of the surface.

15. The method according to claim 10, characterized in that the first and the second images are recorded simultaneously.

REMARKS

By this Preliminary Amendment, certain claims have been amended to eliminate multiple dependent claims.

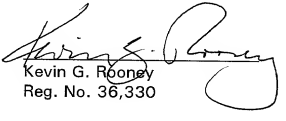
Early and favorable consideration of this application is respectfully requested.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment.

Applicants do not believe that any fees are due in connection with this submission. However, if such petition is due or any fees are necessary, the Commissioner may consider this to be a request for such and charge any necessary fees.

Respectfully submitted,

WOOD, HERRON & EVANS L.L.P.



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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claims 4-6 and 9, 10, 12 and 13 have been amended as follows:

4. (Amended) The method according to [[some]] claim 3, characterised in that the sum $(I_1(x,y)+I_2(x,y))$ of the recorded intensities over the surface issued to obtain an essentially topographically neutral reflectance image of the surface.

5. (Amended) The method according to claim 1 [any of the previous claims], characterised in that the intensity of the first image is recorded with light incident from a first direction and that the intensity of the second image is recorded with light incident from a second direction that is opposite to the reflection angle of the first direction.

6. (Amended) The method according to claim 1 [any of the previous claims], characterised by calculation of the derivative of the area by

$$f'_x(x,y) \approx \frac{1}{\tan\gamma} \frac{I_1(x,y) - I_2(x,y)}{I_1(x,y) - I_2(x,y)}$$

where γ is the angle of incidence of the light.

8. (Amended) The method according to claim [6 or] 7, characterised by integration of the derivative in order to obtain the height function of the surface.

9. (Amended) The method according to claim 1 [any of the preceding claims], characterised by polarisation of the incident light and thereto cross wise polarisation of the reflected light in order to eliminate reflections in the surface and obtain the said diffusely reflected light.

10. (Amended) The method according to claim 1 [any of the preceding claims], characterised in that the first image is recorded with light in a first wavelength region and that the second image is recorded with light in a second wavelength region, distinct from the first wavelength region.

12. (Amended) The method according to claim[s] 11 [10 or 11], characterised in that the first and the second images are recorded simultaneously.

13. (Amended) Use of the method according to claim 1 [any of the preceding claims] for determining the topography of a paper surface.

Claims 14 and 15 have been added.

Method of determining an illuminated surface

TECHNICAL AREA

The present invention relates to a method of determining a surface illuminated by incident light by recording the intensity of light reflected from the area in a first image thereof and recording the intensity of light reflected from the area in a second image thereof, complementary to the first image, taken with another angle of illumination.

The invention is particularly but not exclusively applicable to paper surfaces intended for the application of print.

THE PRIOR ART

SE 508 822 makes known a method and a device for measuring and quantifying surface defects, such as polishing roses that can occur in connection with the polishing of coated sheet metal items. In this method and device, at least two sub-images are recorded with at least one camera under illumination of the test surface with parallel light or light from a point source, whereby the angles of incidence of the light relative to the test surface and/or the camera are different during the recording of different sub-images, after which the sub-images are processed in at least one central unit. After this, one or several difference images of the sub-images are produced, and used to determine the degree of surface defects on the test surface. This known technique, however, provides no guidance in how the recorded sub-images can be used in order to determine the topography of the surface.

DESCRIPTION OF THE INVENTION

An object of the present invention is to provide a photometric method of the type described in the introduction that can rapidly determine the topography of a surface.

According to an aspect of the invention, the intensity (that is, the power per unit area) only of diffusely reflected light is recorded in the two images, and a difference between the recorded intensities of the diffusely reflected light of the first and the second recorded images is determined, in order to obtain a representation of the gradient variations of the surface.

If the difference is normalised by division by the sum of the intensities, a ratio is obtained that is essentially directly proportional to the local derivative of the surface.

The derivative in turn is used to determine the height function of the surface.

The insight that forms the basis of the invention is that the lightness of a topographic surface element depends both on its diffuse reflectance and on its angle relative to the illumination. If images of the surface are taken with different angles of illumination, these will differ due to the topography of the surface, but not due to differences in its diffuse reflectance. This can, according to the invention, be used in image processing operations that distinguish the topography from the reflectance.

BRIEF DESCRIPTION OF DRAWINGS

The invention is described in more detail with reference to the attached drawings, in which **FIG. 1** shows schematically an arrangement for recording images according to the invention; **FIG. 2** shows a model corresponding to FIG. 1 that forms the basis for processing the recorded images; **FIG. 3** shows in the form of a diagram a simplified example of processing a recorded image according to the invention; **FIGS. 4A and 4B** show images of a deeply printed test surface recorded by illumination from the left and from the right of the arrangement according to FIG. 1; **FIG. 5** shows the reflectance of the test surface according to FIG. 4; **FIG. 6** shows the derivative of the test surface in FIG. 4 ; **FIG. 7** shows the topography of the test surface in FIG. 4; **FIG. 8** shows an image of the test surface according to FIG. 4 with contours representing -1 μm; **FIGS.**

9A and 9B show at a higher scale a reflectance image and a topographic image, respectively, of a test surface furnished with printed points; and **FIG. 10** shows profiles of a test surface measured mechanically and measured with an arrangement according to the invention.

DESCRIPTION OF AN EMBODIMENT

The principle of the invention is shown in the arrangement according to FIG. 1. A test surface 1, which in the examples described is a paper surface with an area typically of 5x5 mm, is illuminated by a first light source 2 and by a second light source 3 arranged at two mutually opposite directions. The light sources 2, 3 contain halogen lamps with illumination optics. A camera 4 of CCD type detects and records by a computer 5 the intensity of the reflected light.

The computer 5 is preferably equipped with known hardware and software for image processing. The time required for analysis of an image with a resolution of 512x512 pixels is currently approximately 10 seconds using a 400 MHz standard PC. The mathematical analysis has been carried out using the MATLAB® software.

The invention is based on the detection of diffuse light. Specular reflections from the test surface can be eliminated in the example shown by means of mutually crossed polarizers 6 and 7. In more detail, a polarizer 6 can be placed between the test surface 1 and each light source 2, 3, while a polarizer 7 that is crossed with respect to the polarizer 6 can be placed between the test surface 1 and the camera 4, in such a way that the illuminating light is polarised parallel to the incident plane and the reflected light is polarised at right angles to it.

With reference to FIG. 2, the intensity of the incident light is proportional to $\cos(\alpha)$, where α is the angle of incidence of the illuminating light to the surface 1. Lambert's law

is assumed to be valid for the diffusely spread light. According to this law, the radiance is equal in all directions. This means that the intensity detected by the camera is given by

$$I = I_0 R \cos(\alpha) \qquad [1]$$

where R is the reflectance and I_0 is the intensity measured when $R = 1$ and $\cos(\alpha) = 1$. Scalar multiplication gives a value for $\cos(\alpha)$ as

$$\cos(\alpha) = \mathbf{a} \cdot \mathbf{n} / |\mathbf{n}| = \frac{\sin(\gamma)\frac{\partial f}{\partial x} + \cos(\gamma)}{\sqrt{\left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2 + 1}} \qquad [2]$$

where **a** is the illumination vector $[\sin(\gamma),0,-\cos(\gamma)]$ and **n** is the surface normal $[\partial f / \partial x, \partial f / \partial y, -1]$.

If two images, I_1 and I_2, are recorded with $\gamma_2 = -\gamma_1$, FIGS. 4A, 4B, the partial derivative $\partial f / \partial x$ can be calculated from [1] and [2] as

$$\frac{\partial f}{\partial x} = \frac{1}{\tan\gamma}\frac{I_1 - I_2}{I_1 + I_2} \qquad [3]$$

This expression does not depend on the reflectance. An example of the derivative, calculated from the images in FIGS. 4A, 4B, is shown in FIG. 6, in which the derivative has been coded as a grey-scale image.

In order to obtain the height function of the test surface, the derivative must be integrated. However, since the images contain noise, certain spatial frequencies must be integrated with caution. This is why the derivative should preferably be subjected to a Fourier transform and multiplied by what is known as a Wiener filter:

$$H_R = \frac{H_I^*}{|H_I|^2 + SNR(u,v)^{-1}} \qquad [4]$$

which performs the integration with the suppression of spatial frequencies u and v, which have an expected low signal-to-noise ration, SNR. The frequencies H_I of the surface

include both the partial derivative (in the form of $2\pi iu$) and the light that is spread in the material. For more detailed description of a Wiener filter, refer to *Pratt, W. K.*, (1978), Digital Image Processing, Wiley, New York, 378-387. The surface function, which is shown in FIG. 7, also coded as a grey-value image in which lower surface areas have a darker grey value than higher surface areas, is obtained as the inverse transform of the product.

The local reflectance of the test surface, which provides information about the degree of covering of the print, is approximately obtained as the sum of the images, I_1 and I_2, see FIG. 5.

In order to facilitate understanding of the invention, a simplified one-dimensional "digital" observation of a typical image processing operation is shown in FIGS. 3 A-G.

FIG. 3A shows the test surface, the topography of which, f(x), is to be investigated. In this case the surface has a printed regular pattern.

When the surface is illuminated with oblique illumination from the left, an intensity variation in the diffusely reflected light is obtained, according to FIG. 3B, as a result of variations both in the reflectance (the pattern) and in the topography. Compare also the equivalent image or graphical representation in the two-dimensional case according to FIG. 4A, in which variations in grey-value are equivalent to variations in intensity.

When the surface is illuminated with oblique illumination from the right, a new intensity variation, $I_2(x)$, in the diffusely reflected light is obtained in an equivalent manner, according to FIG. 3C. Compare also the equivalent image in the two-dimensional case according to FIG. 4B.

If the difference between the intensities, $I_1(x) - I_2(x)$, is calculated, a variation which accentuates the topographic variations is obtained, according to FIG. 3D (the variations in reflectance are partially, but not wholly, suppressed), that is, variations in the gradient of the surface.

If the sum of the intensities, $I_1(x) + I_2(x)$, is calculated, a variation that essentially depends only on variations in reflectance is obtained according to FIG. 3E, while the structural or topographical variations are suppressed. In other words, the distribution of colour on the surface is obtained, that is, the presence or absence of print. Compare also the equivalent image in the two-dimensional case according to FIG. 5.

If the ratio $(I_1(x) - I_2(x))/(I_1(x) + I_2(x))$ is calculated, that is, the normalised difference between the intensities, a variation is obtained according to FIG. 3F that essentially only depends on topographic variations, that is, variations in the gradient of the surface.

The ratio is used to calculate the derivative of the surface according to FIG. 3F as

$$f'_x(x) \approx \frac{1}{\tan\gamma} \cdot \frac{I_1(x) - I_2(x)}{I_1(x) + I_2(x)}$$

where γ = the angle of incidence of the illumination, as previously. Compare also the equivalent image in the two-dimensional case according to FIG. 6. In the two-dimensional case the derivative will in an equivalent way become

$$f'_x(x,y) \approx \frac{1}{\tan\gamma} \cdot \frac{I_1(x,y) - I_2(x,y)}{I_1(x,y) + I_2(x,y)}$$

If the derivative is integrated, preferably with the simultaneous suppression of noise as described above, the topography is obtained according to FIG. 3G. Compare also the equivalent image in the two-dimensional case according to FIG. 7.

As the previous description has made clear, in addition to the purely topographic determination (FIG. 7) of a surface, the invention can also be used for the simultaneous determination of the reflectance of the surface (FIG. 5) in the same co-ordinates. In this way, interesting relationships between surface structure and the transfer of print can be studied in detail. In FIG. 8, contours equivalent to a depth of -1 μm from a sliding reference level have been added to the reflectance image from FIG. 5 by a thresholding operation in the image processing computer 5, which explains why printed points are

missing from regions of the printed area. In a similar manner, an examination has been made on the test surface according to FIGS. 9A and 9B whether a particular depth of the depressions in the surface (for example, dark regions in the upper left-hand corner of the topographical map FIG. 9B) can correspond to failed print transfer (missing print points in FIG. 9A in those regions that are darkest in FIG. 9B). This can be used in printing technology as a prediction about in which regions missing printed points can be expected.

In this respect it has become evident that so-called straight thesholding of the topography does not work so well. On the other hand, if a high-pass filter is applied to the topographical map such that long wavelength information is suppressed, and then apply a threshold level of -1 μm, that is to say, in practice thresholding relative to a sliding reference level, then the areas that have a high probability for missing print transfer are marked, see FIG. 8. It is possible to learn from this more about how surface rawness should be measured in a manner that is relevant for printability. The method has also given interesting results for full-tone areas printed flexographic printing (not shown).

It is not necessary that the two images be recorded at different times. For example, the first image can be recorded with the arrangement described in FIG. 1 in a first wavelength region and the second image can be simultaneously recorded from the same camera point in a second wavelength region, complementary or distinct from the first wavelength region (not shown), if the two illuminations use distinct wavelength regions. In this way the possibility or recording processes on the test surface, for example, a region of a paper pathway during production, which is in motion.

Analyses according to the invention of test pieces of LWC paper have shown a high correlation, $r^2=0.95$, between profiles determined according to the invention and profiles determined according to conventional optical and mechanical methods of measuring profiles. In the diagram shown in FIG. 10, the full curve shows the profile determined according to the invention, while the dashed curve shows the same profile of the same paper strip determined by a mechanical contact method of measuring.

CLAIMS

1. A method for determining a surface illuminated by incident light by recording the intensity ($I_1(x,y)$) in light reflected from the surface in a first image thereof and by recording the intensity ($I_2(x,y)$) in light reflected from the surface in a second image thereof, taken with another angle of illumination and complementary to the first image, characterised by

recording the intensity of only diffusely reflected light over the surface in the two images, and

determination of the difference between the recorded intensities of diffusely reflected light over the surface in the first and second images in order to obtain a representation that emphasises variations in gradient of the surface.

2. The method according to claim 1, characterised in that the difference is normalised in order to obtain an image that is reflectance-neutral and which represents variations in gradient, that is, a derivative of the height function of the surface.

3. Method according to claim 2, characterised in that the difference is normalised by division by a sum ($I_1(x,y)+I_2(x,y)$) of the recorded intensities of the surface.

4. The method according to [some] claim 3, characterised in that the sum ($I_1(x,y)+I_2(x,y)$) of the recorded intensities over the surface is used to obtain an essentially topographically neutral reflectance image of the surface.

5. The method according to any of the previous claims, characterised in that the intensity of the first image is recorded with light incident from a first direction and that the intensity of the second image is recorded with light incident from a second direction that is opposite to the reflection angle of the first direction.

6. The method according to any of the previous claims, characterised by calculation of the derivative of the area by

$$f'_x(x,y) \approx \frac{1}{\tan\gamma} \cdot \frac{I_1(x,y) - I_2(x,y)}{I_1(x,y) + I_2(x,y)}$$

where γ is the angle of incidence of the light.

7. The method according to claim 6, characterised by Fourier transformation of the derivative and multiplication thereof by a Wiener filter in order to suppress noise in the recorded intensities.

8. The method according to claim 6 or 7, characterised by integration of the derivative in order to obtain the height function of the surface.

9. The method according to any of the preceding claims, characterised by polarisation of the incident light and thereto crosswise polarisation of the reflected light in order to eliminate reflections in the surface and obtain the said diffusely reflected light.

10. The method according to any of the preceding claims, characterised in that the first image is recorded with light in a first wavelength region and that the second image is recorded with light in a second wavelength region, distinct from the first wavelength region.

11. The method according to claim 10, characterised in that the first image is recorded by illumination with light of a first frequency and that the second image is recorded by illumination with light of a second frequency that deviates from the first frequency.

12. The method according to claim 10 or 11, characterised in that the first and the second images are recorded simultaneously.

13. Use of the method according to any of the preceding claims for determining the topography of a paper surface.

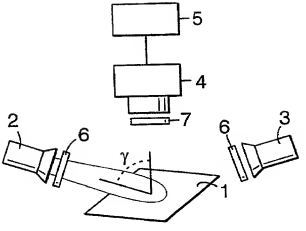

FIG.1

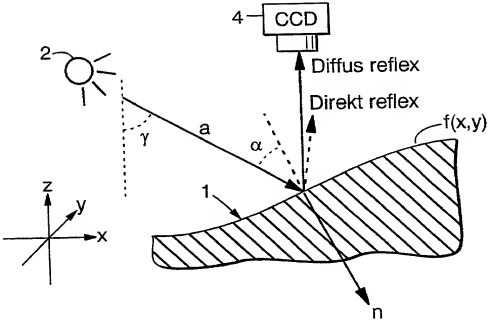

FIG. 2

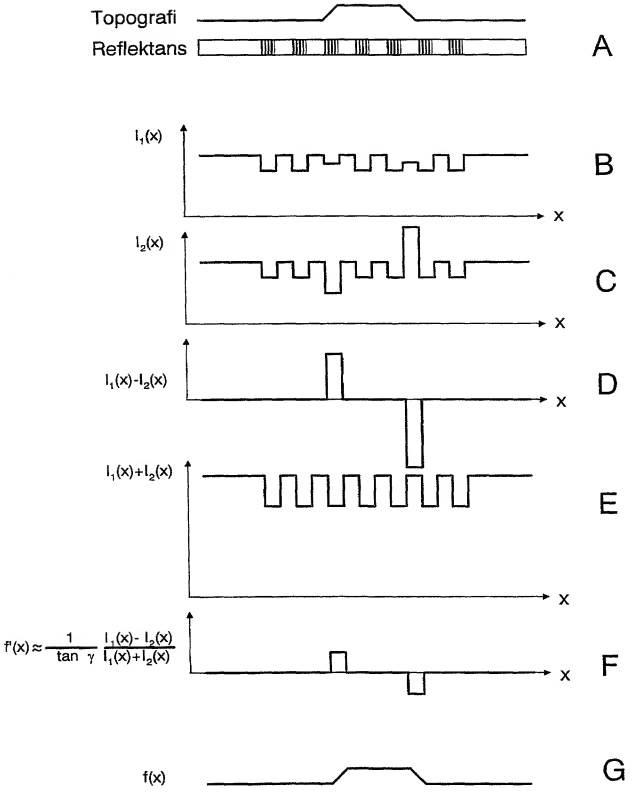
Topografi
Reflektans
A
$I_1(x)$
B
x
$I_2(x)$
C
x
$I_1(x)-I_2(x)$
D
x
$I_1(x)+I_2(x)$
E
x
$f'(x) \approx \frac{1}{\tan \gamma} \frac{I_1(x)-I_2(x)}{I_1(x)+I_2(x)}$
F
x
f(x)
G

FIG.3

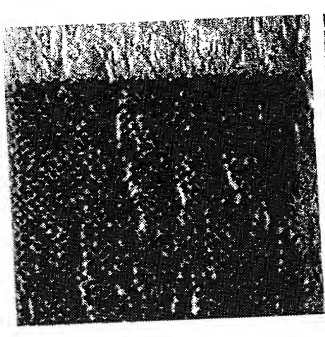

FIG.4A

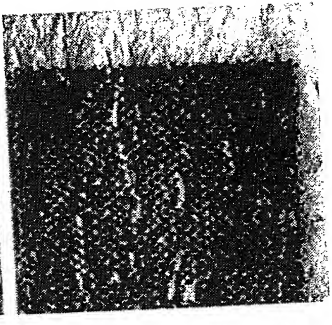

FIG.4B

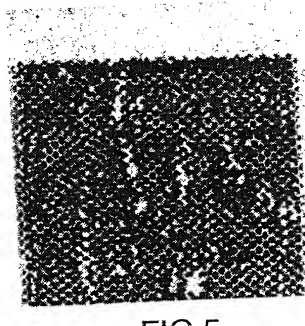

FIG.5

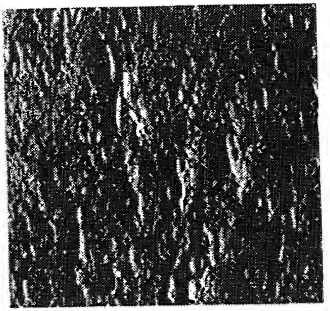

FIG.6

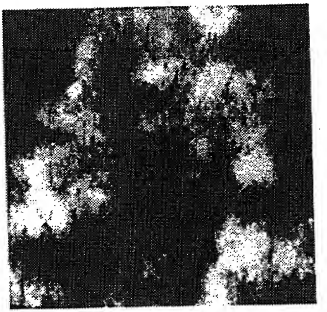

FIG.7

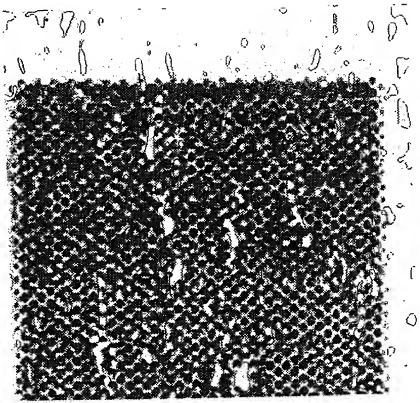

FIG.8

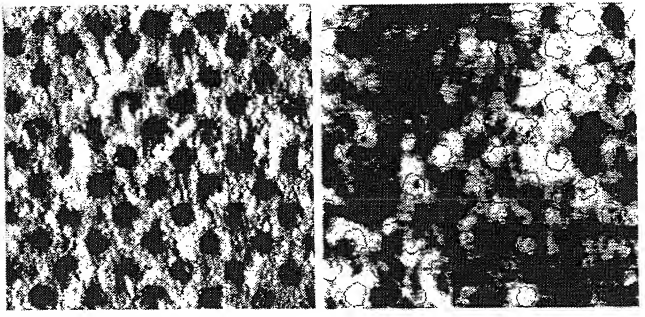

FIG.9A FIG.9B

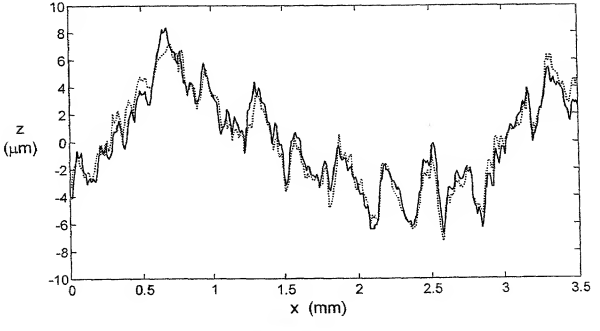

FIG.10

#4

Declaration and Power of Attorney For Patent Application

Försäkran avgiven i samband med ansökan om patentskydd i Amerikas förenta stater

Swedish Language Declaration

Som nedan nämnd uppfinnare förklarar jag att:

Min hemvist, postadress och medborgarskap är som nedan angivits.

Jag är övertygad om att jag är den ursprungliga, första och enda uppfinnaren (om endast ett namn uppges nedan) eller en av de ursprungliga och första meduppfinnarna (om flera namn anges nedan) av den uppfinning för vilken patent söks, benämnd.

_____

_____

_____,

och vars beskrivning och patentkrav

(korsa lämplig ruta)

☐ bifogas,

☐ ingavs den _____ under

ansöknings-nummer _____

ändrades den _____ (eventuellt).

Jag förklarar härmed att jag har granskat och förstår innehållet i den ovan nämnda beskrivningen och patentkrav med de eventuella ändringar som gjorts.

Jag är medveten om min skyldighet att upplysa om allt som kan vara av betydelse för prövningen av denna ansökan i enlighet med "Title 37, Code of Federal Regulations, §1.56(a)."

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

METHOD OF DETERMINING AN

ILLUMINATED SURFACE

_____,

the specification of which

(check one)

☐ is attached hereto.

XX ☐ was filed on July 25, 2001 as

Application Serial No. 09/890,056

and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

Swedish Language Declaration

Jag yrkar härmed prioritet enligt "Title 35, United States Code, §119" från de(n) patentansökning(ar) eller ansökning(ar) om uppfinnarcertifikat som uppgivits nedan; Jag har också nedan uppgivit varje utländsk patentansökan eller ansökan om utländskt uppfinnarcertifikat som har en tidigare ingivningsdag än vad ansökan har från vilken prioritet begärts.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior foreign applications Tidigare ansökning(ar) utomlands			Priority claimed Prioritet begärd	
PCT/SE00/00024 (Number) (nummer)	PCT (Country) (land)	10 January 2000 (Day/Month/Year Filed) (ingivn.dag/månad/år)	[X] Yes Ja	[ ] No Nej
9900276-8 (Number) (nummer)	Sweden (Country) (land)	28 January 1999 (Day/Month/Year Filed) (ingivn.dag/månad/år)	[X] Yes Ja	[ ] No Nej
(Number) (nummer)	(Country) (land)	(Day/Month/Year Filed) (ingivn.dag/månad/år)	[ ] Yes Ja	[ ] No Nej

Jag yrkar härmed på de förmåner som i enlighet med "Title 35, United States Code, §120" tillkommer varje amerikansk ansökan som uppräknas nedan, och om innehållet i samtliga patentkrav i denna (dessa) ansökning(ar) inte angivits i den tidigare amerikanska ansökningen på det sätt som krävs enligt första stycket i "Title 35, United States Code, §112" är jag medveten om skyldigheten att uppge all den information som blivit tillgänglig under tiden mellan den tidigare ansökningens ingivningsdag och den nationella ansökningens ingivningsdag eller PCT-ansökningens internationella ingivningsdag, se "Title 35, Code of Federal Regulations, §1.56(a)":

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.) (ansökan, nr)	(Filing Date) (ingivningsdag)	(ärendets status) (ej avgjort, patent meddelat, avslag)	(Status) (patented, pending, abandoned)
(Application Serial No.) (ansökan, nr)	(Filing Date) (ingivningsdag)	(ärendets status) (ej avgjort, patent meddelat, avslag)	(Status) (patented, pending, abandoned)

Vidare förklarar jag att dessa uppgifter lämnats i medvetande om att avsiktligt falska uppgifter och liknande kan straffas med böter eller fängelse eller bådadera enligt "Section 1001 of Title 18 of the United States Code", och att sådana avsiktligt falska uppgifter kan äventyra giltigheten av ansökningen eller ett därav beviljat patent.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Swedish Language Declaration

FULLMAKT: I egenskap av uppfinnare befullmäktigar jag härmed följande advokat/er och/eller ombud att tala och svara i denna ansökan inför US Patent and Trade Mark Office. (*ange namn och registrerings-nummer nedan*):

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (*list name and registration number*)

See Page 4 of 4

All korrespondens i ärendet sänds till:

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Wood, Herron & Evans, L.L.P.
441 Vine Street
2700 Carew Tower
Cincinnati, OH 45202

Alla tel.samtal i ärendet ställs till: (*namn, tel.nr*)

Direct Telephone Calls to: (*name and telephone number*)
Kevin G. Rooney
(513) 241-2324

Ende resp. forste uppfinnarens fullständiga namn 1-00	Full name of sole or first inventor Per-Ake JOHANSSON
Uppfinnarens namnteckning Datum	Inventor's signature Date 17 Oct 2001
Stadigvarande bostad	Residence Dalagatan 20, SE-113 24 Stockholm, Sweden SEK
Nationalitet	Citizenship Swedish
Postadress	Post Office Address Same as above
Ev. andre meduppfinnares fullständiga namn 2-00	Full name of second joint inventor, if any Peter HANSSON
Uppfinnarens namnteckning Datum	Second Inventor's signature Date
~~Stadigvarande bostad~~ Residence Verkstadsgatan 22, 117 36 Stockholm	Residence ~~Genberg, Gardsfogdevagen 29~~ ~~SE 161 70 Bromma, Sweden~~
Nationalitet SEK	Citizenship Swedish
Postadress	Post Office Address Same as above

Samma uppgifter och namnunderskrifter från ytterligare uppfinnare bifogas på löst blad och fästs vid "Försäkran".

(Supply similar information and signature for third and subsequent joint inventors.)

POWER OF ATTORNEY: As named inventor, I hereby appoint I hereby appoint Richard H. Evans (R. No. 19,755), John D. Poffenberger (R..No. 20,245), Bruce Tittel (R. No. 22,324), Donald F. Frei (R. No. 21,190), David J. Josephic (R. No. 22,849), A. Ralph Navaro, Jr. (R. No. 23,050), David S. Stallard (R. No. 25,930), J. Robert Chambers (R. No. 25,448), Gregory J. Lunn (R. No. 29,945), Kurt L. Grossman (R. No. 29,799), Clement H. Luken, Jr. (R. No. 32,742), Thomas J. Burger (R. No. 32,662), Gregory F. Ahrens (R. No. 32,957), Wayne L. Jacobs (R. No. 35,553), Kurt A. Summe (R. No. 36,023), Kevin G. Rooney (R. No. 36,330), Thomas W. Humphrey (R. No. 34,353), Keith R. Haupt (R. No. 37,638), Theodore R. Remaklus (Reg. No. 38,754), Scott A. Stinebruner (R. No. 38,323), Joseph R. Jordan (R. No. 25,686), C. Richard Eby (R. No. 25,854), David E. Pritchard (R. No. 38,273), David H. Brinkman (R. No. 40,532), J. Dwight Poffenberger, Jr. (R. No. 35,324), Beverly A. Lyman, Ph.D. (R. No. 41,963), Kristi L. Davidson (R. No. 44,643), P. Andrew Blatt, Ph.D. (R. No. 44,540), David E. Jefferies (R. No. 46,800), David E. Franklin (R. No. 39,194) and William R. Allen, Ph.D. (R. No. P-48,389) in care of Wood, Herron & Evans, L.L.P., 2700 Carew Tower, Cincinnati, Ohio 45202, and telephone number (513) 241-2324, my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

United States Patent & Trademark Office

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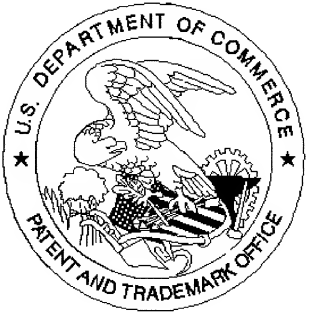

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